REMOTE ACCESS BETWEEN THE COF-CC, THE SSCC, THE POIC AND OTHER DECENTRALIZED COLUMBUS GROUND SEGMENT FACILITIES

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ABSTRACT

In the era of the International Space Station Alpha (ISSA) it is anticipated to have the capability to remotely access on-line data processing systems and data bases of several facilities of the Columbus ground segment. The idea of having a decentralized operations scenario with the possibility that each agency which provides an element to the Space Station can operate its own element, needs fast and flexible information exchanges with low failure rates and high reliability to assure safe operations of the whole station. This might be achieved by processing specific data only in those centers where the expertise is, but provide other centers the capability to remotely login for monitoring these data at any time the information is needed. This gives a high operational flexibility for operation teams and users.

1. INTRODUCTION

During the Spacelab missions FSLP, D-1, and D-2 all users where located centraly at the Payload Operations Control Center (POCC) and accommodated in so called user rooms, either at JSC/Houston (USA) or at GSOC/Oberpfaffenhofen. This concept needed a lot of effort during the preparatory phase where all the user requirements had to be implemented into the POCC, and besides that, user equipment like EGSE or reference experiments had to be transported and reinstalled at the POCC. Also personnel had to travel to the POCC for training, simulations and for the complete operations period. All these facts caused failures, additional workload and were cost driving.
Based on these experiences of a 'Centralized Operations Concept' a new concept was developed during the early Columbus study phases. This new 'Decentralized Operations Concept' foresees, that users do not have to be located at the POCC but rather at remote locations, nationally sponsered User Support and Operations Centers (USOC), or even in their User Homebases (UHB).
These quasi remote located user rooms have the advantage that users can stay in their environment or in a nearby USOC, which provides expertise in experiment development, implementation and operation. Another aspect is, that during the Columbus long-term missions personnel don't have to be sent on mission for extended periods. Some of these advantages have been experienced already during recent Spacelab (e.g. ATLAS) and MIR missions, where European users in particular were provided with operational means at their home bases or USOCs. Figure 1 shows as an example, how the decentralized operations were performed during the EUROMIR 95 mission.
But even in such a decentralized concept the operations configuration has to be determined premission and is quasi frozen during the whole mission. Changes to these predefined configurations are restricted and not easy to perform.
In the future this problem may be facilitated, due to the capability of a remote access between control centers data, which will be processed only once at a center of expertise, and information can be acquired from where ever it is suitable.

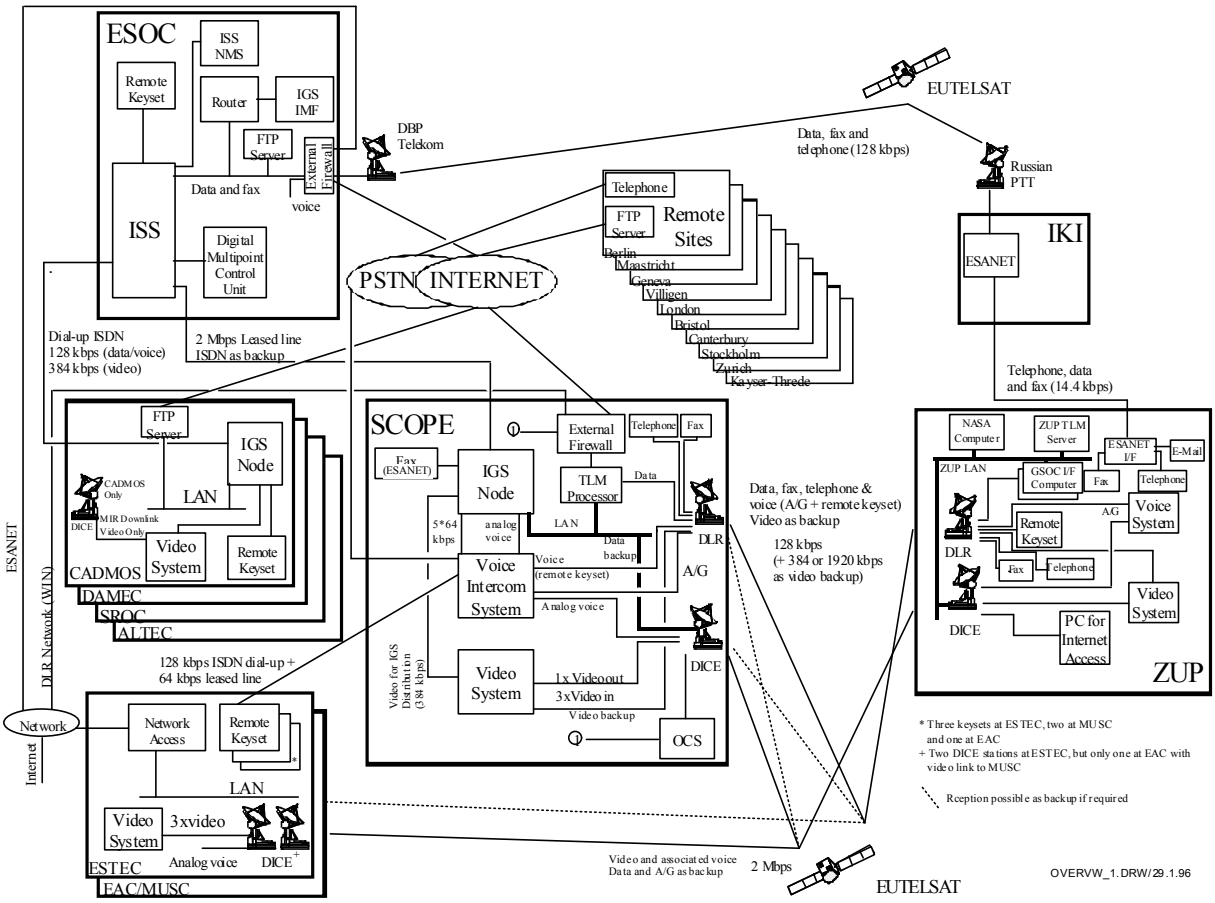

Figure 1. EUROMIR 95 Ground Network Configuration

2. PROPOSAL FOR A REMOTE ACCESS EXPERIMENT

Several space agencies will be involved in the mission operations of future manned space missions on the International Space Station Alpha (ISSA).
The idea that each agency which provides an element to the station will have the possibility to operate his own element in a decentralized manner, will need fast information exchanges with low failure rates and high reliability for secure operations of the space station as a whole.
This might be achieved by processing system/payload specific data only in those control centers where the expertise of these data is. All the other (or authorized) control centers will have the capability to remotely login to the online data processing systems and data bases, to select and acquire the data, which they need for monitoring, at any time the information is required.

Therefore, it is proposed to demonstrate the capability of a remote access to an on-line data processing system and to data bases as an experiment in connection with operations activities during a real mission, where data will be disseminated and processed in real-time. Candidates, where such a demonstration could be performed are the control centers at DLR/GSOC and NASA/JSC. Possible opportunities would be upcoming missions like STS-80 with the payload ORFEUS-SPAS-2 in Nov. 1996, STS-85 with payload CRISTA-SPAS-2 in July 1997, or any other cooperative mission with Germany, where real-time data downlink will be available. The experiment would be carried out, using existing data connections between DLR/GSOC and NASA/JSC, and using available H/W and S/W,

which only need to be adapted to current interfaces at DLR/GSOC, and the to be processed parameters of the selected mission. Possible data connections are the existing communications I/F between DLR/GSOC and NASA/JPL in connection with NASCOM, the ESA developed Interconnect Ground Subnet (IGS) with existing nodes at GSOC/DLR and NASA/JSC, or as an alternative the Internet for offline activities.
The experiment would be a precursor activity for the Space Station/Columbus Orbital Facility (COF) operations, since the remote access between operations facilities of the Columbus ground segment is a strong requirement for the Columbus era. Performed in a realistic environment, it will augment and expand the performed prototyping activities for a Command & Control System during the Columbus Extended Design Consolidation Phase (E-DCP), and it is expected, that it will give a lot of insight into possibilities for remote access between control centers, and raise the confidence in the safety/security of such an operations mode.

3. SUMMARY OF GOALS

The Remote Access Experiment would

- demonstrate controlled remote access capability from NASA/JSC to DLR/GSOC, and vice versa in a realistic environment, involving European and NASA ground and space elements
- be used as input for modifications and adaptations of Columbus Project developments (CGS)
- demonstrate and investigate the capability for the use of other electronic information exchanges and possibly for backup purposes in a timely and efficient manner
- gain 'on-the-job' experience for the Columbus ground operations segment, in particular for the Columbus Orbital Facility Control Center (COF-CC) and it's interfaces to NASA/JSC.

4. EXPERIMENT OVERVIEW

An overview of the proposed communication configuration for the remote access experiment is given in Figure 2 below. The configuration shown is for a possible Shuttle mission which will be similar to the real situation during Columbus operations.
The mission data is downlinked from the Shuttle via TDRSS to the White Sands ground station and relayed to NASA/JSC via DOMSAT. A selected set of raw data will be prepared by the JSC systems, in the form of CCSDS packets (TBC) which will be transferred from NASA/JSC to DLR/GSOC, either via the NASA communication network (NASCOM) and the existing Intelsat link between NASA/JPL and DLR/GSOC. Another possibility to transmit data, would be via the existing IGS nodes and the IGS network.
This data, which will presumably include both, European experiment H/K data and selected space segment system data, will then be processed in real-time and distributed for display purposes within DLR/GSOC.
The remote access capability from NASA/JSC to these in real-time processed data again is available via NASCOM and the Intelsat link to the roof top terminal at DLR/GSOC, or via the IGS nodes and the IGS network.
For the first moment it seems to be nonsensical to send raw data from one place to another, process them here and pick them up from the first place again, instead of processing the data there. But this exactly reflects the Columbus situation, where only a subset of COF housekeeping data will be processed at the SSCC. In case of contingency or other problems, when the SSCC needs more and

detailed COF information they will be capable to log into the COF-CC processing system and select only the data they need, at the same time as they are displayed in the COF-CC.

In addition, to the data links as mentioned above, it is proposed to investigate the use of Internet and the World Wide Web for near real-time or off-line monitoring purposes. It is of great interest to find out the performance and reliability differences between the used networks and to see if this would be a good medium for supporting users during Space Station payload operations.

The DLR/GSOC systems will provide remote access to the following data types for monitoring purposes in a fashion which is planned for the Space Station era :

- European experiment H/K data
- selected space segment system data
- planning data &
- operations reports

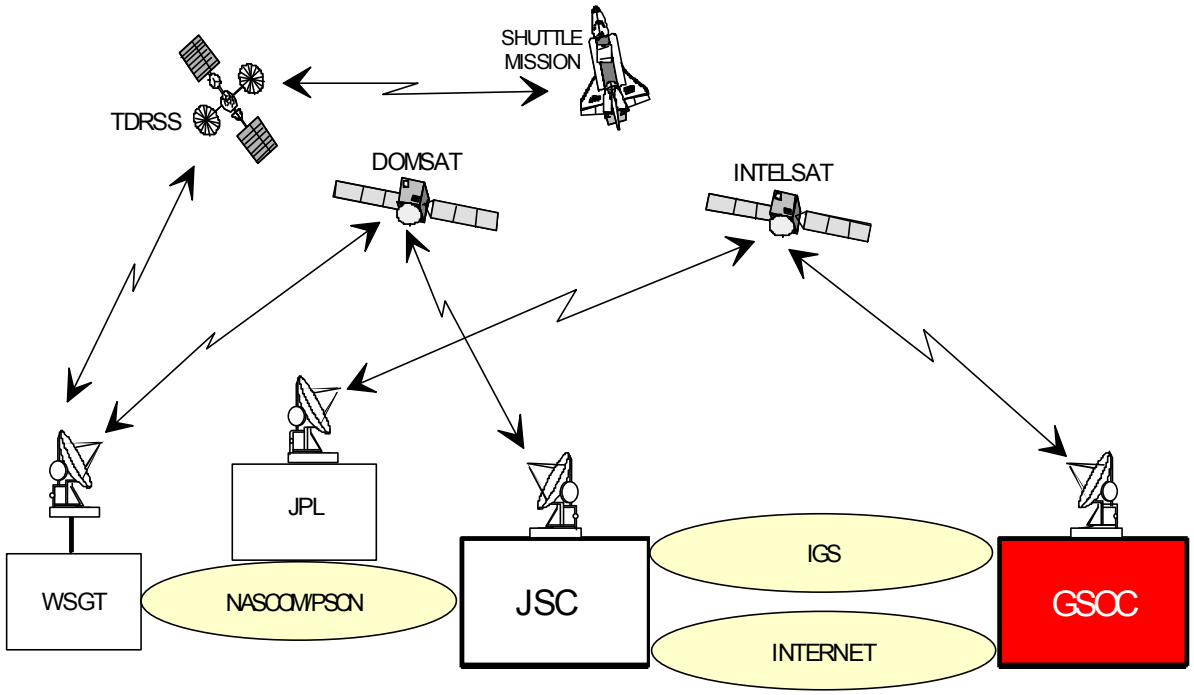

Figure 2. Network Configuration for the Remote Access Experiment

5. DETAILED DESCRIPTION

Figure 3. provides a more detailed overview of the experiment configuration.
Raw experiment H/K data (e.g. from SPAS) is received at DLR/GSOC via the Intelsat roof top terminal or via the IGS from JSC. The raw data is passed to the telemetry processor where the housekeeping data monitoring parameters are generated for display at the DLR/GSOC workstations. The processed H/K parameters are distributed using a broadcast mechanism as in the present

DLR/GSOC implementation. Therefore a telemetry server is required in addition, to filter processed H/K parameters selected by the remote user, in this case NASA/JSC, before passing them over the network. This avoids transmitting all broadcast parameters over the network and is therefore more communication bandwidth efficient. This means, the parameters selected by the remote user (NASA/JSC) are only those which are presently being monitored by the user.
All raw data and processed housekeeping data are stored and archived by the data processing system. This data can be also remotely retrieved from the archive for any offline or post mission analysis, using the same client interfaces as for real-time data retrieval.

In addition to the above described configuration it is proposed to create a Web Server with access to both, telemetry display pages and mission planning product and report pages over the Internet. As a performance comparison it also proposed to run the Web access via the IGS (see dotted line between the IGS local node and the Internet access at NASA/JSC), where the IGS provides effectively an 'Intranet', i.e. a dedicated Internet. This would give valuable experience in using Web technology for supporting distributed operations, especially concerning remote users. It has already proved to be an effective medium during the EUROMIR 95 mission, where remote users accessed a Web server at DLR/GSOC for planning data and operations reports.

For any remote access via the Internet, standard Internet Firewall technology is used to avoid any insecure access to the operational system. In the case of communications via the IGS, firewall capabilities are not necessary as the IGS provides private communication lines which prohibit public access.

6. FUTURE IDEAS AND CONCLUSIONS

This experiment would be a first step towards a communications scenario, where not only one dedicated control center has remote access to another dedicated control center, but where many control facilities, user operations centers, and even user home bases have the capability to remotely access the processing systems of each other. Of course it has to be made sure, that only authorized facilities/users will have the permission for such a service, and no other unauthorized idividual must have the capability to access, disturb or corrupt these processing systems.

The second step towards the mentioned communications scenario would be to include European users and industry in such an experiment. Possible candidates for this experiment would be user sites like the MUSC in Cologne, the CADMOS in Toulouse, the DAMEC in Copenhagen, the SROC in Brussels, and a USOC in Turin, which did already have IGS connections with DLR/GSOC during the EUROMIR 95 mission (see Figure 1.), when they were provided with data on a regular basis.
Looking to the future, the ultimate goal of the remote access concept could be that the control centre provides access to it's applications (rather than just Web pages) which may be utilized by remote users via standard Internet/Web/Net Browser capabilities using Java technology. This would allow a user to run a control centre application locally, and create an application to application interface over the Internet/Intranet for selected parameter/data transfer, which would improve Web access performance considerably as only selected data is transferred and not complete Web pages.

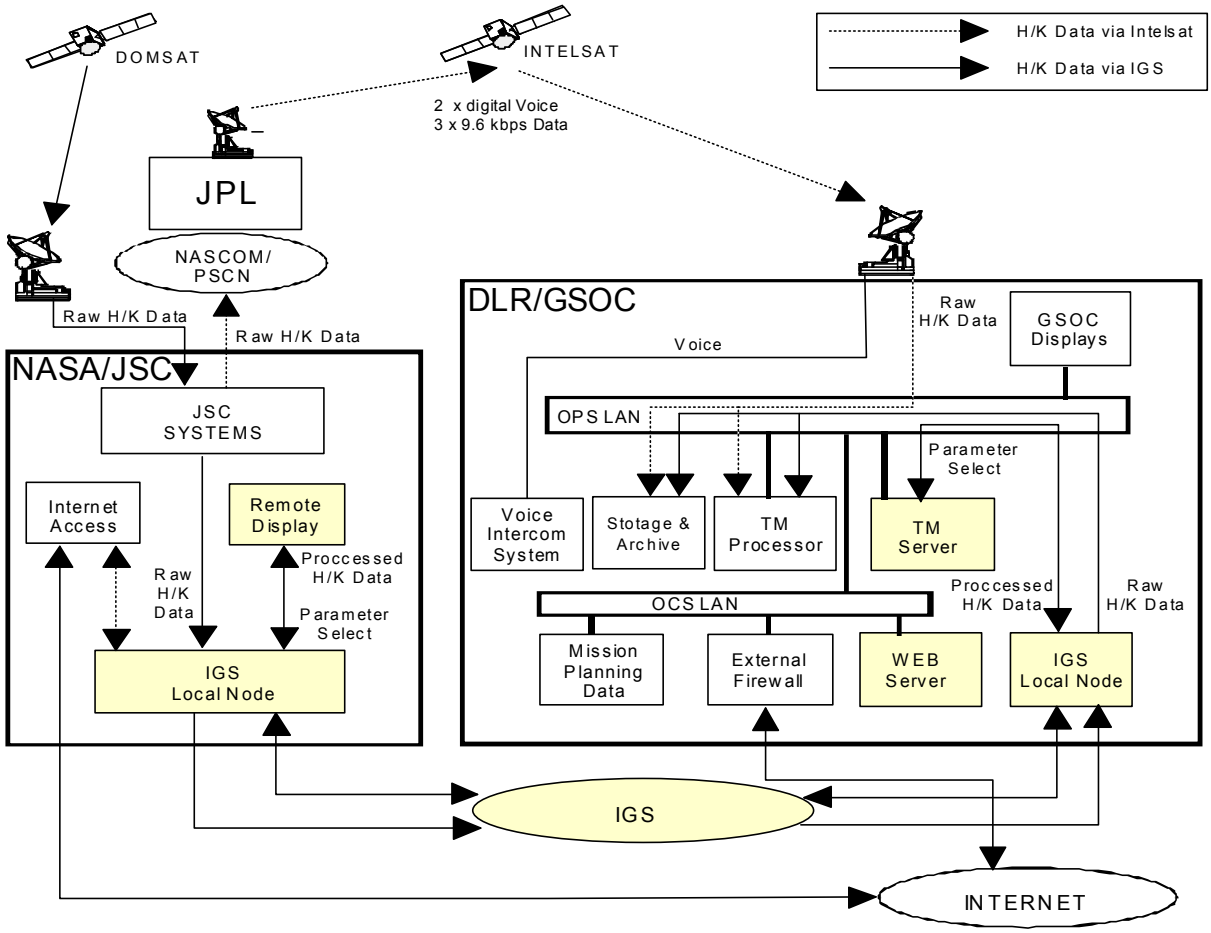

Figure 3. Configuration for the Remote Access Experiment

Outfited with security access rights and with acceptable Web performance, remote users could access all applications to view payload housekeeping and subsystem ancillary data, mission planning data, timelines and operational progress data.
From the user's "client" hardware prespective it would be relatively platform-independent, taking advantage of current trends towards open standards for network browsing and application development. The client could be fully implemented using a modem- or ISDN interface-equipped personal computer, notebook or workstation, running the standard Browser with a security module or locally-defined applications and tools. It is believed that none of the applications present significant technical risk, even based on current technologies. Although the provision of suitable response times could require some improvement in bandwidth and/or server technology to be most effective.

Taking all these features into consideration, a further step would be to extend the use of this interface, by requesting operational changes and additional supporting data, by communicating with control centre personnel via an internet audio interface similar to the current DLR/GSOC remote keyset which is based on ISDN, and by perhaps visualizing the operations as they occur using remotely updated graphic interfaces such as timeline displays. Assuming all security concerns can be resolved, the interface may additionally support user tele-commanding, if not directly via the Internet, at least through the provision of a dedicated secure link i.e. an 'Intranet' which would be provided by the IGS.
The interface could additionally support user mission preparation activities, e.g., by allowing the investigator to submit his/her operational requirements and requests, procedural data, etc., and to review, comment and download/utilize mission preparation products, when desired.

Depending upon the flexibility of the tools provided, the external user could additionally configure his own displays and special computations remotely. Finally, remote access could also be used effectively for allowing operations personnel in offices and on-call personnel to be easily involved in the resolution of a contingency using their PCs from home.

Looking forward to Space Station operations remote access capabilities based on Web technology as described above, it would allow remote users to easily be integrated into COF-CC operations with just a few basic resources e.g., a personal computer, Internet access, and appropriate access rights. Such an implementation would be of considerable benefit for COF/ISSA investigators who wish either to avoid the expense of implementing their own control center capabilities or who prefer the mobility granted by remote access. This implementation would also serve remote organizations, such as the COF Mission Management Team (ESA) and NASA centers, enabling them to view current COF-CC operations aspects without complicated interfaces.